Hydrogeology for Underground Injection Control in Michigan:

Part 1

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Regional Water Resources

REGION I: SOUTHEAST MICHIGAN

Introduction

The area designated as Region I, Southeast Michigan, includes ten counties within two state planning and development regions (fig.3.10). Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties are members of the Southeast Michigan Council of Governments, centered in Detroit. The three remaining counties, Genesee, Lapeer, and Shiawassee, comprise the GLS Region 5 Planning and Development Commission, which has its offices in Flint.

Population

In 1980 the population of Region I, Southeast Michigan, was 5,273,758, or 57 percent of Michigan's total population (table 3.7). The region experienced a 0.4 percent decrease in population from 1970, and is the only region in Michigan to experience a population loss. The decrease represents an outflow of 23,275 people from the region since 1970. Nine of the region's 10 counties experienced population increases during this period, the greatest, 70.1 percent, occurring in Livingston County. Wayne County experienced the only decrease in the region but this decrease of 12.5 percent was greater than the total population increase in the other nine counties.

Eight of the ten most highly populated cities in Michigan are located in this region. Detroit, the largest city in Michigan with a population of 1,203,399, accounts for 22.8 percent of the regional population and 13.0 of the state population. The four most populous counties in Michigan are also located in this region, and include Wayne, Oakland, Macomb, and Genesee Counties. Wayne and Oakland Counties far exceed all other counties in population with 2,337,240 and 1,011,793 inhabitants respectively. The two counties combined contained 36.1 percent of the total population in Michigan, 25.2 percent of 10.9 percent respectively.

Industry and Agriculture

The retail and wholesale trade values for Southeast Michigan are highest in Wayne and Oakland Counties. Detroit, in Wayne County, is the oldest city in the Midwest and a major international lake port. The Detroit Metropolitan area industries produce 80 percent of all cars made in the U.S. Approximately 46 percent of earnings in Wayne County are from manufacturing industries, 36 percent in Oakland County.

The automobile industry is the major source of employment in Macomb County. Manufacturing industries employ 54.5 percent of the county population. Similarily, Genesee County's industry is primarily automotive with 70 percent of the manufacturing jobs, or approximately 50 percent of the county's population, employed by the automobile industry. Also, many people commute from counties such as Shiawassee County which has 43.5 percent of its employed population engaged in manufacturing.

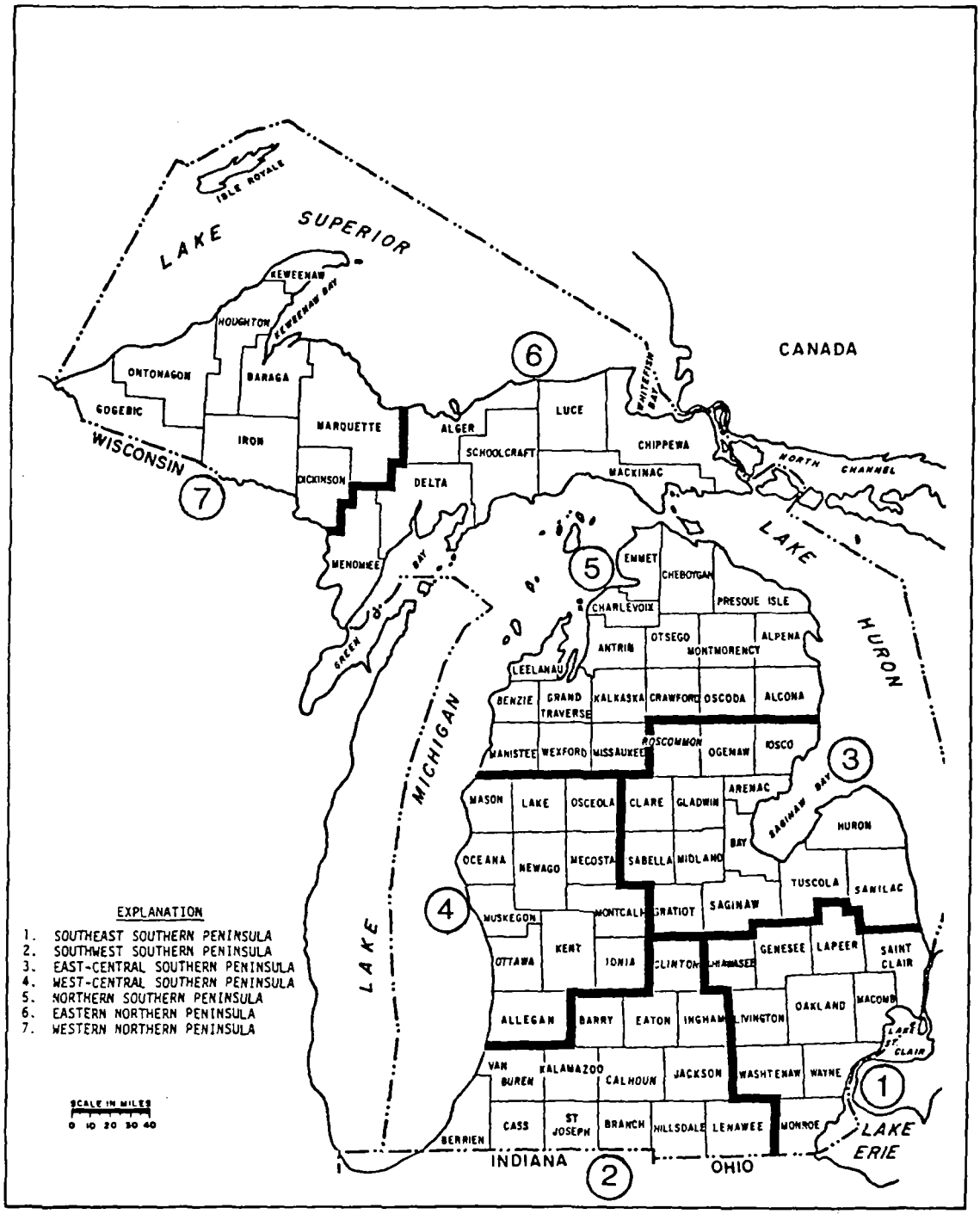

Figure 3.7. Water resource report regions.

GEOLOGY

Topography

The preglacial topography of Southeast Michigan has strongly influenced the present topography (pl. 13). Prior to glaciation, the landscape comprised part of two physiographic regions, the Thumb Upland in the northwest and the Erie-Huron Lowland in the southeast. The Upper Devonian Berea Sandstone forms the approximate boundary between the two regions (pl. 6). The Thumb Upland is underlain by formations younger than the Berea, primarily the Coldwater Shale and Marshall Sandstone, and the Erie-Huron Lowland is developed on formations older than the Berea (Mozola, 1953). Glacial deposition has preserved, or even exaggerated the upland/lowland relationship. Thus Southeast Michigan has two distinct topographies, a nearly featureless plain in the southeast, and an elevated, hilly area in the northwest with plains also present in the extreme northwestern portion of the region.

The southeastern and northern plains formerly constituted the beds of a succession of preglacial lakes formed when glacial ice occupied the basins of the modern Great Lakes. The level of the highest beach line is about 850 feet above mean sea level (MSL) near Imlay City in Lapeer County, decreasing to about 800 feet at the Michigan-Ohio border. All of the area lying below these elevations consists of lake-bed plains, which slope gently southeastward and comprise the land surface of Monroe County, nearly all of Wayne, Macomb, and St. Clair Counties, southeastern Oakland County, northern Shiawassee, and northwestern Genesee Counties. The flatness of these plains is interrupted only by major drainage channels, faint ridges marking the beaches of former glacial lakes, and subdued, water-laid moraines.

In contrast to the nearby flat topography of the lake plains, the topography of the northwestern part of the region consists of belts of morainal hills and pitted outwash plains. In Genesee and Shiawassee Counties the moraines are superimposed, increasing the local relief. The topography in this area has greater relief and is characterized by knobs, knolls and pitted outwash plains.

The general elevation of the moraines increases to the northeast, reaching a maximum of 1221 feet (MSL) at Pine Knob in Independence Township, Oakland County. Several morainic knolls in Oakland, Livingston, Macomb and Washtenaw Counties stand at elevations of more than 1100 feet. Those counties which span both lake-bed plains and morainal regions exhibit the greatest relief with Oakland County having a maximum relief of 630 feet and Macomb County 578 feet of relief. In contrast, Monroe County lies entirely within the lake plain and has only about 160 feet of relief. The regional slope of the land surface in Southeast Michigan is southeast and northwest, away from the elevated morainal trend. Lake Erie, with an average surface elevation of 568.6 feet represents the lowest point in the area. Thus, maximum relief in Southeast Michigan is about 650 feet.

Upland Lakes

Upland lake statistics for Southeast Michigan are summarized in Table 3.11. The table includes those lakes having surface areas greater than five acres and does not distinguish between man-made and natural lakes. This region contains a total of 1,021 lakes covering 82,582 acres. Oakland County has the greatest number of lakes with 394 (39 percent) covering 37,749 acres, or 46 percent of the region's lakes. The majority of the lakes, 746 (73 percent) are classified by the Michigan Department of Natural Resources as warm-water lakes. Oakland County has the greatest number of two-story lakes in the state with 142 (13 percent).

Glacial movement has played a prominent role in shaping the present landscape of Michigan and developing its most important aquifer system. During the Pleistocene Epoch, four major glacial advances probably crossed the state, but only the last, the Wisconsinan, left positively identified significant deposits (See Section II, Glacial Geology). The nature of these glacial deposits as related to aquifer systems is briefly summarized below.

Moraines

Moraines are ridges composed of glacial till material, a heterogeneous mixture of clay, sand, and bounders in various proportions. Most moraines originate at the stabilized front of an active glacier where large quantities of rock debris melt out of the ice and are deposited in ridges parallel to the ice front. The proportions of clay in the morainal sediments determines the aquifer characteristics.

Till Plains

Till plains are usually developed between end moraines. These gently rolling areas are underlain by till, referred to as ground moraine. The unsorted nature of glacial till results in low permeability and moderate porosity. These deposits are therefore generally incapable of yielding large volumes of water except when from local interbedded sand lenses, which may provide an adequate water supply to meet domestic needs.

Lake Plains

Lake beds (lacustrine) are deposits of ancestral lakes. They are typically composed of clay and silt and may be several tens of feet thick with low relief. Lacustrine sediments have low permeability and porosity and do not yield large quantities of water. Lake beds may locally contain sands, and are capable of meeting local water needs.

Outwash Plains

Outwash plains are formed from sediment deposited from glacial melt-waters. Outwash deposits are generally composed of well-sorted sands and gravels, and have high porosity and permeability. The coarsest sediments are generally deposited near the ice front with finer sands and silts deposited further from the ice front. The deposits generally constitute excellent aquifers.

Hydraulic Characteristics

Information on the hydrogeology of regions was acquired principally from engineering reports, well records, regional and county ground-water studies, and miscellaneous reports and personal communications with the Michigan Geological Survey and the United States Geological Survey. Aquifer characteristics most commonly available were well capacity, specific capacity, transmissivity and coefficient of storage.

These four hydraulic characteristics reflect the performance of the aquifer for each location and well. Well capacity, which is a measure of the well yield in gallons per minute (gpm), is the most commonly reported hydraulic characteristic. The greater the well capacity, the greater the production potential of the aquifer.

The specific capacity of a well is the well capacity, or yield, per unit of drawdown, usually expressed as gallons per minute per foot of drawdown (gpm/ft). The specific capacity reflects the aquifer's ability to recharge the well and normally the higher the specific capacity, the smaller the drawdown. Conversely, a low specific capacity is typically related to a larger drawdown. Specific capacities greater than 100 gpm/ft represent good aquifers for irrigation and municipal systems. Specific capacities of 0.1 to 1.0 represent fair to good aquifers for domestic purposes.

Transmissivity is defined as the rate of flow of water at the prevailing temperature through a vertical strip of aquifer one unit wide, extending the full saturated thickness of the aquifer, under a unit hydraulic gradient. Transmissivity data are presented in gallons per day per foot (gpd/ft). Transmissivities greater than 100,000 gpd/ft represent good aquifers for irrigation and municipal systems. Transmissivities of 1000 gpd/ft are adequate for domestic supplies.

The coefficient of storage, or storativity, of an aquifer is defined as the volume of water which an aquifer releases from, or takes into, storage per unit surface area of aquifer per unit decline or rise of head. Storativity is dimensionless, and for unconfined aquifers, normally ranges from 0.02 to 0.30. Storativity for confined aquifers normally ranges from 5.0^{-3} (0.005) to 5.0^{-5} (0.00005).

Hydraulic Characteristics Of Glacial Drift Aquifers

Data on the hydraulic characteristics of 1265 glacial drift wells were available from 152 locations within Region 1, (table 3.12). Oakland County had information for the most locations (37) and Washtenaw County had information for the greatest number of wells (773). Monroe County had information on the fewest glacial drift wells (4). Well depths in the region ranged from 24 feet in Lapeer County to 335 feet in Washtenaw County.

Nine values (4 percent) for well capacity were available for naturally flowing wells. Well capacity for flowing wells ranged from 3 gpm in Washtenaw County to 75 gpm in Monroe County. The well capacity of non-flowing wells ranged from 1 gpm in St. Clair County to 5000 gpm in Monroe County. For additional information see Table 3.12.

Specific capacity values for Region I ranged from 0.01 gpm/ft in St. Clair County to 600 gpm/ft in Washtenaw County. Genesee County was the only county that lacked specific capacity data.

Transmissivity values for the region ranged from 6450 gpd/ft to 500,000 gpd/ft in Oakland County. The coefficient of storage ranged from 3.4×10^{-7} (0.00000034) in Livingston County to 3.04 in Oakland County.

Water Quality In The Glacial Drift Aquifer

Water quality data for the glacial drift aquifer was available from the Michigan Department of Public Health for all the counties in Region 1 except Monroe and Wayne. The region included 96 reporting Community Public Water Supply Systems in 8 counties for which 363 water samples were analyzed from 189 wells in the glacial drift aquifer. Oakland County had the most abundant water quality data with 193 water samples analyzed from 104 wells in 58 water systems. Lapeer County had data for only 3 water samples from 3 wells in 1 water system. Table 3.13 presents data on 7 water quality parameters included in the EPA Interim Primary Drinking Water Standards. Range and mean were calculated for each parameter and standard deviation was calculated for counties with 30 or more water samples.

The parameters nitrate, fluoride, chloride, iron, and sulfate are shown on Plate 23, Quality of Water from Community Public Wells. These data represent Community Public Supply Systems only. Plate 25 shows total dissolved solids and specific conductance for Community Public Supply Systems and private wells.

None of the samples analyzed from Region 1 contained nitrate in excess of the primary maximum contaminant level (primary MCL). Only one water sample (< 1 percent) contained fluoride in excess of the primary MCL. The mean fluoride concentration for Region 1 was 0.47 mg/l, ranging from 0.0 mg/l to 2.60 mg/l. Fourteen water samples (4 percent) from 5 counties contained chloride in excess of the secondary maximum contaminant level (secondary MCL). The mean chloride concentration for

TABLE 3.12 - HYDRAULIC CHARACTERISTICS OF THE GLACIAL DRIFT AQUIFER SYSTEM, REGION 1 (SOUTHEAST MICHIGAN).

Location	Number of Wells	Depth of Well (feet)	Well Capacity (gpm)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Coefficient of Storage
Genesee County						
Clio	1	50	250		21,400	0.33
Grand Blanc	1				29,500	2.08×10^{-3}
Montrose	1				58,500	0.013
Mt. Morris	1	113	1000		34,285 to 35,675	7.96×10^{-5} to 8.01×10^{-5}
Atlas Twp.	1	92	32			
Richfield Twp.	1	74	8			
Lapeer County						
Dryden	3	43-159	12-60	0.19-4.29		
Imlay City	1	69	350	11.7		
Almont Twp.	1	100	20	1		
Arcadia Twp.	1	157	15	1		
Attica Twp.	1	160	45	1.13		
Dryden Twp.	1	178	20	0.67		
Goodland Twp.	1	135	30	1.2		
Imlay Twp.	2	70-225	40-75	0.48-1.48		
North Branch Twp.	1	24	5*			
Rich Twp.	1	63	15			
Livingston County						
Brighton	3	93-141	50-475			
	3		320-600			
	1	95	300	18.75		
Hamburg	1	46	20			
	1	65	10*			
Howell	3	92-94	400-600			
Pittsford	1	52	165	20.1		
Brighton Twp.	1	87	524		33,000	5.46×10^{-3}
	1	73	15			
	2	99	187-260	3.3-4.9	15,000 to 16,000	5.0×10^{-6}
	3	52-129	10-230	0.23-3.71		
Genoa Twp.	3		390		42,900	
	1	93	30	2.5		
Green Oak Twp.	1	116	420		57,000	0.14
	2	126	100-250		14,000	4.4×10^{-3}
	4	59-219	12-300	0.6-15.0		
Hamburg Twp.	4	67-210	10-40	0.59-2.22		
Hartland Twp.	1	47	70*			
Howell Twp.	1	102	70	7		
Putnam Twp.	1	118	20	0.57		
Tyrone Twp.	1	43	20*			
Tyrone-Deerfield Twps.	2	60-115	60-200		6600	3.4×10^{-7}
Unadilla Twp.	2	54-67	2-6	1		
Macomb County						
Armada	1	81	292	4.95		
Centerline	1	128	1000	45.5		
Fraser	1	109	520	24.76		
New Haven	1	30	50	3.85		
	1	58	100-200	6.9	14,000	5.0×10^{-4}
	1		125		16,000	4.4×10^{-4}
Richmond	1	203	250	2.98		
Romeo	3	148-187			369,000 to 443,000	8.9×10^{-5} to 1.2×10^{-3}
	2	55-100	200-350	11.3-28.6		

Location	Number of Wells	Depth of Well (feet)	Well Capacity (gpm)	Specific Capacity (gpm/ft)	Transmissivity (gpd.ft)	Coefficient of Storage
St. Clair County Cont'd						
Kenochee Twp.	1	74	6	0.75		
Kimball Twp.	2	93-106	10-12	2-12		
Lynn Twp.	2	88-118	30-60	0.56-0.81		
Port Huron Twp.	3	124-131	5-20	0.10-6.67		
Riley Twp.	2	50-137	7-12	0.35-0.54		
	2	154-169	8-300	0.73-2.70		
St. Clair Twp.	2	101-145	2-11	0.03-2.2		
	1	123	50			
Shiawassee County						
Bancroft	1	93	201			
Hopkins Lake	3				10,000	
New Lothrop	3	51-78	104-369	9.9-20.5		
Perry	2		250-401	22.7-31.0		
	1	70	400-735	28.6-33.4		
	1	70	190	9.5		
Bennington Twp.	3		345 (combined)		11,445	5.1×10^{-4}
Washtenaw County						
Ann Arbor	3	91-196	1050-4860	20-600		
Chelsea	3		400-1000			
Dexter	1	51	100	6.7		
	1	80	120			
Saline	3				20,400 to 21,600	8.91×10^{-5} to 2.85×10^{-4}
	2		325-550			
Ypsilanti	6	87-102	450	25-180		
	9	50-95	700-3500			
Ann Arbor Twp.	32	51-240	10-162	0.2-7.5		
Augusta Twp.	11	26-102	4-20	0.06-1.2		
Bridgewater Twp.	16	39-146	10-40	0.1-15		
Dexter Twp.	50	36-173	2-168	0.04-20		
Freedon Twp.	45	43-164	5-30	0.14-7.5		
Lima Twp.	31	33-149	12-28	0.3-15		
Lodi Twp.	64	33-256	1-50	0.05-12		
Lyndon Twp.	8	68-105	6-512	0.7-19		
Manchester Twp.	34	49-218	5-30	0.75-30		
	1	35	3*			
Northfield Twp.	58	31-304	3-425	0.2-20		
Pittsfield Twp.	59	40-216	6-180	0.14-500		
	2	38-91	10-2000	10-500		
	1	32	45*			
Salem Twp.	56	32-335	5-60	0.2-17.5		
Salines Twp.	20	67-258	10-325	0.2-25		
Scio Twp.	57	30-235	10-200	0.14-18.3		
	1	52	20*			
Sharon Twp.	14	70-130	9-30	0.2-12		
	1	54	8*			
Superior Twp.	37	43-223	3-60	0.03-14.0		
Sylvan Twp.	14	37-205	8-40	0.09-7.5		
York Twp.	49	41-311	5-650	0.04-32.4		
Ypsilanti Twp.	22	25-268	7-974	0.08-26.3		
Webster Twp.	64	36-204	4-60	0.07-7.5		
Wayne County						
Northville	1	61	550	91.7		
Plymouth	3	115-117	40-450			
	1	118	4000	83.3		
1S 11E	1	126	100			
1S 12E	1	213	73	1.43		
Canton Twp.	2	64-80	20-50	1.54-2.38		
Livonia Twp.	1	86	10	0.33		
Northville Twp.	1	112	450	28.1		
Romulus Twp.	1	75	15	0.43		
Sumpter Twp.	1	61	13	0.43		
Van Buren Twp.	2	117-122	400-1000	11.4-166.7		

*gpm rate is the yield from natural flow (source: Flowing Wells in Michigan, 1974, Michigan Geological Survey)

Region 1 was 50 mg/l, ranging from 0 mg/l to 615 mg/l. Three hundred twenty-two water samples (89 percent) from all 8 counties contained iron in excess of the secondary MCL. The mean iron concentration for Region 1 was 1.61 mg/l, ranging from 0.0 mg/l to 8.00 mg/l. Five water samples (1 percent) from 2 of the 8 counties contained sulfate in excess of the secondary MCL. The mean sulfate concentration for Region 1 was 50 mg/l, ranging from 0 mg/l to 295 mg/l. Sixty-seven water samples (18 percent) from 7 of the 8 counties contained total dissolved solids in excess of the secondary MCL. The mean of total dissolved solids was 401 mg/l, ranging from 240 mg/l to 1619 mg/l. In fifty-two water samples (14 percent) from 7 of the 8 counties specific conductance levels exceeded the secondary MCL. The mean specific conductance was 712 umhos/cm, ranging from 405 umhos/cm to 2650 umhos/cm.

Hydraulic Characteristics Of Bedrock Aquifers

Data on the hydraulic characteristics of 248 bedrock wells were available from 114 locations within Region 1 (table 3.14). Mississippian aquifers served most of the locations (66) and supplied the greatest number of bedrock wells (128). Of the eleven bedrock aquifers within the region, the Mississippian Marshall Sandstone served the most locations (25) and supplied the greatest number of wells (40). The Devonian Dundee Limestone served the fewest locations (4) and supplied the least number of wells (5). Well depths in the region ranged from 28 feet in Wayne County to 502 feet in Livingston County.

Eight well capacity values (3 percent) were available for naturally flowing wells and ranged from 1 gpm for the Marshall Sandstone in Lapeer County to 200 gpm for the Marshall in Wayne County. Well capacities for the Pennsylvanian Saginaw Formation ranged from 50 gpm to 610 gpm. The Mississippian Marshall Sandstone ranged from 4 gpm to 505 gpm and the Mississippian Coldwater Shale from 10 gpm to 170 gpm. The Mississippian Berea Sandstone ranged from 2 gpm to 768 gpm, the maximum range within the Mississippian aquifer system. The four Devonian aquifers ranged in well capacity from 2 gpm to 900 gpm; the highest obtained from the Devonian Detroit River Group in Monroe County. Well capacities for Silurian aquifers ranged from 5 gpm to 550 gpm.

Specific capacities for Region 1 ranged from 0.03 gpm/ft for the Berea Sandstone and the undifferentiated Devonian in Washtenaw County to 20 gpm/ft for the Saginaw Formation in Livingston County.

Transmissivities were available only for the Saginaw Formation and Marshall Sandstone, and ranged from 2500 gpd/ft for the Saginaw in Genesee County to 158,100 gpd/ft for the Marshall in Oakland County. Coefficients of storage were available only for the Saginaw Formation and ranged from 3.0×10^{-5} (0.00003) to 1.3×10^{-4} (0.00013) in Genesee County.

TABLE 3.14 - HYDRAULIC CHARACTERISTICS OF THE BEDROCK AQUIFER SYSTEMS, REGION 1 (SOUTHEAST MICHIGAN).

Location	Number of Wells	Depth of Well	Well Capacity (gpm)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Coefficient of Storage
Pennsylvanian Aquifer System						
Saginaw Formation						
Genesee County						
Burton Twp.	1		100		2500	8.0×10^{-4}
Clayton Twp.	1	183	90			
Genesee Twp.	1	200	50			
Grand Blanc	1	315	120	8	27,000	
	1	355	400	4	8700	
	1				5650	3.0×10^{-5}
	1				3600	1.3×10^{-4}
Livingston County						
Fowlerville	2	225	200-300			
Hanely Twp.	2	170-300	40-610	16		
Marion Twp.	1	264	350	20		
Shiawassee County						
Byron	1	175	260		4400	
Corunna	1		150		4120	7.8×10^{-5}
Mississippian Aquifer System						
Michigan Formation - Marshall Sandstone						
Lapeer County						
Almont Twp.	1	126	10	10		
Attica Twp.	1	220	50	2.5		
St. Clair County						
Mussey Twp.	1	150	20	0.5		
Marshall Sandstone						
Genesee County						
Davison	3	210-260	190-455			
Burton Twp.	1	304	230	2.30		
Lapeer County						
Arcadia Twp.	2	245-280	10-100	2.33		
	1	116	5*			
Attica Twp.	1	200	6	0.14		
Burnside Twp.	1	240	40	1.33		
	1	159	1*			
Goodland Twp.	1	280	80	2.0		
Metamora Twp.	1	157	10*			
Livingston County						
Hamburg Twp.	1	144	20	2.22		
Iosco Twp.	2	82-131	4-10	0.3		
Marion Twp.	1	502	250	31		
Osceola Twp.	1	120	25*			
Putnam Twp.	4	90-194	12-100	0.34-1.54		
Unadella Twp.	4	100-128	10-45	0.27-5.0		
Oakland County						
Holly	1	210	505		115,000-158,000	
Groveland Twp.	1	175	4*			
Independence Twp.	1	264	300		23,000	
Shiawassee County						
Perry	1	200	100			
Washtenaw County						
Dexter Twp.	2	99-150	4-15	0.1-5		
Lyndon Twp.	1	201	30	0.23		
Manchester Twp.	1	210	7	0.7		
Sharon Twp.	2	170-175	18-20	6.7-9		
	1	84	200*			
Sylvan Twp.	4	70-109	3-18	0.2-7.5		

Location	Number of Wells	Depth of Well	Well Capacity (gpm)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Coefficient of Storage
Coldwater Shale						
Lapeer County						
Almont	1	184	170	1.68		
Dryden Twp.	1	210	20	1		
Imlay Twp.	1	200	30	0.88		
Livingston County						
Brighton Twp.	3	205-360	20	0.23-0.63		
Green Oak Twp.	1	223	15	0.10		
Macomb County						
Armada Twp.	1	240	15	0.1		
Washington Twp.	1	195	12	1.33		
Oakland County						
Avon Twp.	2	215-234	10-11	0.08-0.2		
Commerce Twp.	1	292	60	0.97		
St. Clair County						
Berlin Twp.	1	190	10	0.19		
Shiawassee County						
New Lathrop	1	193	20	0.39		
Perry	3	200	70-115			
Washtenaw County						
Lima Twp.	1	132	12	0.57		
Manchester Twp.	1	245	10	5		
Scio Twp.	1	76	12	6		
Webster Twp.	1	65	12	1.33		
Berea Sandstone						
Livingston County						
Genora Twp.	1	187	25	0.58		
Oakland County						
Bloomington Twp.	2	221-300	15-768	0.22-12.8		
Farmington Twp.	1	182	7	0.08		
Southfield Twp.	3	117-180	5-60	0.38-2.4		
West Bloomfield Twp.	1	403	20	0.5		
St. Clair County						
Casco Twp.	1	210	6	0.08		
China Twp.	2	131-136	15	0.26-0.54		
Emmet Twp.	1	220	20	1.0		
Ira Twp.	1	122	18	2		
Kimball Twp.	1	137	12	0.35		
St. Clair Twp.	1	148	12	0.52		
Washtenaw County						
Pittsfield Twp.	2	244-290	30-125	0.38-4.0		
Saline Twp.	1	159	12	1.09		
Superior Twp.	1	245	15	0.88		
Ypsilanti Twp.	1	165	2	0.03		
Wayne County						
Canton Twp.	1	207	5	0.08		
Livonia Twp.	1	234	30	1		
Undifferentiated						
Washtenaw County						
Lima Twp.	3	72-155	3-12	0.07-0.6		
Lyndon Twp.	6	108-240	6-100	0.1-20		
	6	77-201	9-300	0.2-2.3		
Scio Twp.	3	76-145	12-60	6		
Sharon Twp.	10	84-252	10-200	1.3-22.2		
Sylvan Twp.	5	88-170	9-18	0.4-0.67		
Webster Twp.	9	65-224	5-12	0.05-12		

Location	Number of Wells	Depth of Well	Well Capacity (gpm)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Coefficient of Storage
Devonian Aquifer System						
Traverse Group						
Washtenaw County						
Augusta Twp.	2	120	15	0.17		
York Twp.	2	119-288	8-25	0.09-0.42		
Ypsilanti Twp.	1	150	2	0.06		
Wayne County						
1S 12E	1	126	100			
Dundee Limestone						
Monroe County						
Dundee Twp.	1	84	20	4		
Milan Twp.	1	127	20	0.67		
Washtenaw County						
Augusta Twp.	2	92-128	8-18	0.53-0.72		
Wayne County						
Romulus Twp.	1	183	110	2.68		
Detroit River Group						
Monroe County						
6N 7E	1	48	10	2		
	1	71	900			
London Twp.	1	63	10	1		
Washtenaw County						
Augusta Twp.	1	63	20	5		
Wayne County						
Grosse Isle Twp.	1	86	15	3		
Huron Twp.	3	28-59	10-40	1.67-4.44		
Sumpter Twp.	1	102	41	4.56		
Sylvania Sandstone						
Monroe County						
Carleton	1	100	100	1.59		
Maybee	1	56	100	33.3		
Ash Twp.	1	51	6	0.27		
Berlin Twp.	1	51	3	0.38		
Dundee Twp.	1	63	15	7.5		
Rainsville Twp.	6	45-70	4-12	0.16-1.0		
Summerfield Twp.	2	69-93	10-15	1-3		
Whiteford Twp.	1	100	15	3		
Wayne County						
Berlin Twp.	1	66	50	3.13		
Brownstown Twp.	1	135	300	4.41		
Undifferentiated						
Washtenaw County						
Augusta Twp.	31	63-302	2-40	0.03-0.72		
Pittsfield Twp.	2	286	10	0.08		
Saline Twp.	3	159-278	10-15	0.33-1.1		
Superior Twp.	3	180-245	3-15	0.9		
Ypsilanti Twp.	4	132-237	2-20	0.06-1.2		
Silurian - Devonian Aquifer System						
Undifferentiated						
Monroe County						
7S 9E	3	55-74	10-35			
	1	64	10*			
Lasalle Twp.	3	66-81	15-25			

Location	Number of Wells	Depth of Well	Well Capacity (gpm)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Coefficient of Storage
Washtenaw County						
Augusta Twp.	1	118	10			
Wayne County						
Huron Twp.	1	475	40*			
Silurian Aquifer System						
Bass Island Group						
Monroe County						
Bedford Twp.	3	71-90	6-254	1.2-7.06		
Frenchtown Twp.	1	200	350			
Ida Twp.	2	68-71	5-15	1.5		
Lasalle Twp.	2	67-68	5-20	0.1-4		
Whiteford Twp.	3	78-85	10-90	2.25-10		
Salina Group						
Monroe County						
7S 9E	1	81	20	4		
Bedford Twp.	3	67-86	15	1.5-15		
Erie Twp.	3	57-150	10-550	0.5-13.1		

*gpm rate is the yield from natural flow (source: Flowing Wells in Michigan, 1974, Michigan Geological Survey)

Generally, areas of thinner drift had a high percentage of bedrock wells, and areas of thicker drift had a low percentage of bedrock wells. Most areas with greater than 10 percent bedrock wells were located in areas where the glacial drift thickness is less than 100 feet. Lapeer County and the eastern half of Genesee County were the only areas within the region with drift thicknesses between 100 and 200 feet and greater than 10 percent bedrock wells. In the central portion of the region, which had a smaller percentage of bedrock wells, drift thickness is generally greater than 100 feet. Much of this area, especially in Oakland County, exceeds 200 feet in drift thickness.

WATER USE

Municipal Water Use

Data were available for 152 of 253 municipal water systems in Region 1 (table 3.20). The region contained the largest number of municipal systems in the state. Surface water supplied the largest volume (91 percent) of water used by municipalities, 713,550,971 gallons per day. Drift aquifers supplied 5 percent (36,679,585 gallons per day) to the region. Combined drift and surface water sources supplied 4 percent (27,036,633 gallons per day). Bedrock wells and combined bedrock sources (drift aquifers and bedrock wells) supplied less than 1 percent each of the water used. Wayne County accounts for 59 percent of the total reported regional water use. The total quantity of water used in Region 1 far exceeds that of any of the other seven state regions.

Public Water Supplies

There are two types of public water supplies, "community" and "non-community" (pl. 22). A "community" water supply is a public water supply which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. A "non-community" water supply is one that is not a community water supply, i.e. serves fewer than 15 service connections and fewer than 25 year-round residents.

Community Public Water Supplies

In Region 1, 308 community water supplies were served by a variety of sources including glacial drift, bedrock, surface waters, purchased waters, and unspecified sources (table 3.21, pl. 22). The majority (39 percent) of community water supplies purchased water from unreported sources. Glacial drift wells supplied 32 percent of the community water supplies; bedrock wells served 6 percent. Surface waters served as a source for 5 percent of the community supplies in the Region. Oakland County had the largest number of community water supplies, 103 or 33 percent of the total in the region.

TABLE 3.20 - MUNICIPAL WATER USE IN REGION 1 (SOUTHEAST MICHIGAN).
(Source: Michigan Department of Public Health, 1980,
Community Public Water Supply Computer Data File)

REGION 1 (SOUTHEAST MICHIGAN)

Source	Total Water Use (AVG. GPD)	Percentage of Total
Drift Aquifers	36,679,585	5
Bedrock Aquifers	1,861,248	< 1
Drift and Bedrock Aquifers	5,166,613	< 1
Surface Water	713,550,971	91
Surface Water and Drift Aquifers	29,036,216	4
COMBINED TOTAL WATER USE (AVG. GPD)	788,294,633	

	Drift Aquifers	Bedrock Aquifers	Drift & Bedrock Aquifers	Surface Water	Surface Water & Drift Aquifers	Springs	Total All Sources
Genesee County							
No. of Systems	7	11	3	14			35
No. of Systems Reporting Water Use	2	4	3	3			12
Total Reported Water Use (AVG. GPD)	1,023,767	192,357	2,166,523	35,166,436			38,549,083

	Drift Aquifers	Bedrock Aquifers	Drift & Bedrock Aquifers	Surface Water	Surface Water & Drift Aquifers	Springs	Total All Sources
			Wayne County				
No. of Systems				42			42
No. of Systems Reporting Water Use				41			41
Total Reported Water Use (AVG. GPD)				465,653,962			465,653,962

TABLE 3.21 - SOURCE OF MAJOR COMMUNITY WATER SUPPLIES IN REGION 1 (SOUTHEAST MICHIGAN).
(Source: Michigan Department of Public Health, 1980, Community Public Water Supply Computer Data File)

Genesee County

Community	Source of Community Water Supplies				
	Drift Aquifers	Bedrock Wells	Drift and Bedrock Wells	Purchased	Unspecified
Flint				X	
Burton			X (Saginaw) [a]		
Fenton	X				
Flushing				X	
Davison		X (Michigan-Saginaw)			
Grand Blanc		X (Saginaw)			
Swartz Creek					X
Mount Morris				X	
Clio				X	
Montrose	X				
Linden		X (Marshall)			
Otisville			X (Saginaw-Marshall)		
Others [b]	5	8	1	10	9
Total Number of Supplies (45)	7	11	3	14	10

Lapeer County

Community	Source of Community Water Supplies		
	Drift Aquifers	Bedrock Wells	Purchased
Lapeer			X [c]
Imlay City			X [c]
Almont			X [c]
Columbiaville		X (Michigan)	
North Branch		X (Michigan)	
Dryden	X		
Clifford		X (Michigan)	
Metamore	X		
Others	1	1	1
Total Number of Supplies (11)	3	4	4

[a] Bedrock aquifer in parenthesis.
[b] Subdivisions, apartments, and industrial supplies.
[c] Incomplete data.

Wayne County		
	Source of Community Water Supplies	
Community	Purchased Water	Surface Water
Detroit		X
Livonia	X	
Dearborn	X	
Westland	X	
Dearborn Heights	X	
Taylor	X	
Lincoln Park	X	
Garden City	X	
Allen Park	X	
Inkster	X	
Highland Park	X	
Southgate		X
Hamtramck	X	
Romulus	X	
Grosse Pointe Woods	X	
Wayne	X	
Harper Woods	X	
Ecorse	X	
River Rouge	X	
Grosse Pointe Park	X	
Melvindale	X	
Plymouth	X	
Grosse Pointe Farms		X
Grosse Pointe	X	
Flat Rock		X
Gibraltar	X	
Woodhaven	X	
Rockwood	X	
Northville	X	
Grosse Pointe Shores	X	
Belleville	X	
Others	11	0
Total Number of Supplies (42)	38	4

Industrial Water Use

Public agencies in Michigan have collected very little information on the sources and quantities of ground water used by industry in Michigan. Annual summaries of ground-water data for Michigan compiled by the U.S. Geological Survey show monthly and annual water pumpage for the major ground water users in each county (Huffman, annually, table 3.89).

Ground water used by industry is reported for Kalamazoo and shown to be very significant. Three large industrial ground water users account for over one-half of the reported ground-water withdrawals from the glacial drift in the county. The Upjohn Company is the single largest industrial ground water user and uses almost as much as the total annual production of the City of Kalamazoo, the largest municipal ground water user.

Alloytek Inc. utilizes an average of 13 percent of the reported ground water use in Kent County, where Lake Michigan is the source for the major municipal systems. By contrast, the industrial ground water use accounts for less than four percent of the total reported ground water use in Eaton and Lenawee Counties.

An inventory of non-community public water systems in Michigan (MDPH, 1980) revealed that 626 industries used ground water for their drinking water source (table 3.90). Although this inventory was not intended to document the sources of industrial process water, it is assumed that the same source has been used to supply process water. Ninety-two industries in Oakland County, 58 industries in Berrien County, and 30 industries in Jackson and Kent Counties were among the highest industrial users of ground water in Michigan. Ten or more industries used ground water in fifteen counties and seventeen counties had no industries reporting ground water use.

At the time of this writing the Michigan Department of Natural Resources has scheduled to undertake a survey of industrial water use in the state to be published in 1982.

TABLE 3.89 - SELECTED INDUSTRIAL AND PUBLIC WATER USERS.
(Source: G.C. Huffman, 1973 thru 1978, Ground-water data for Michigan, U.S. Geological Survey open-file reports)

COUNTY	INDUSTRY	DATE	INDUSTRIAL USE gals. x 10^6	COUNTY TOTAL gals. x 10^6	PERCENT INDUSTRIAL
Eaton	Oldsmobile Parts Warehouse	1973	23.6	1,705.4	1.38
		1974	18.4	1,817.0	1.01
		1975	19.9	1,705.8	1.17
		1976	15.1	1,389.7	1.08
		1977	10.3	1,799.9	0.57
		1978	7.3	1,960.7	0.37
Ingham	Oldsmobile Forge No. 2	1973	178.8	13,388.7	1.34
		1974	102.9	12,425.1	0.82
		1975	132.6	12,031.8	1.10
		1976	115.6	13,413.0	0.86
		1977	137.6	13,669.9	1.00
		1978	133.3	13,869.5	0.96
Kalamazoo	Brown Company	1973	2,292.6	16,296.8	14.07
		1974	3,230.8	17,076.8	18.91
		1975	3,019.0	16,090.5	18.76
		1976	3,428.4	17,331.5	19.78
		1977	3,353.9	17,599.9	19.06
		1978	3,160.5	17,758.9	17.80
	Simpson-Lee Paper Co.	1973	407.0	16,296.8	2.50
		1974	453.0	17,076.8	2.65
		1975	396.0	16,090.5	2.46
		1976	428.8	17,331.5	2.47
		1977	365.7	17,599.9	2.08
		1978	303.0	17,758.9	1.71
	Upjohn Company	1973	5,859.1	16,296.8	35.95
		1974	5,750.2	17,076.8	33.67
		1975	5,173.3	16,090.5	32.15
		1976	5,561.7	17,331.5	32.09
		1977	6,056.0	17,599.5	34.41
		1978	6,370.6	17,758.9	35.87
Kent	Alloytek Inc.	1973	---	371.1	
		1974	---	991.0	
		1975	---	818.2	
		1976	131.9	788.8	16.72
		1977	129.8	1,195.5	10.86
		1978	121.1	1,189.1	10.18
Lenawee	Fisher Body, Tecumseh	1973	23.8	711.9	3.34
		1974	17.4	804.5	2.16
		1975	16.3	754.6	2.16
		1976	14.9	748.9	1.99
		1977	13.6	844.7	1.61
		1978	10.1	831.2	1.22

TABLE 3.90 - NUMBER OF INDUSTRIES IN MICHIGAN COUNTIES USING NON-COMMUNITY PUBLIC DRINKING WATER SYSTEMS.
(Source: Michigan Department of Public Health, 1980, Non-Community Public Water System Inventory)

Alcona County	0	Grand Traverse County	0	Midland County	1
Alger County	0	Gratiot County	2	Missaukee County	2
Allegan County	8	Hillsdale County	9	Monroe County	7
Alpena County	3	Houghton County	0	Montcalm County	1
Antrim County	1	Huron County	2	Montmorency County	2
Arenac County	5	Ingham County	10	Muskegon County	0
Baraga County	0	Ionia County	6	Newaygo County	1
Barry County	2	Iosco County	10	Oakland County	92
Bay County	1	Iron County	0	Oceana County	2
Berrien County	58	Isabella County	1	Ogemaw County	10
Branch County	2	Jackson County	30	Ontonagon County	0
Calhoun County	21	Kalamazoo County	21	Osceola County	2
Cass County	15	Kalkaska County	12	Oscoda County	6
Charlevoix County	8	Kent County	30	Otsego County	3
Cheboygan County	9	Keweenaw County	0	Ottawa County	16
Chippewa County	1	Lake County	0	Presque Isle County	5
Clare County	0	Lapeer County	0	Roscommon County	1
Clinton County	3	Lenawee County	16	Saginaw County	3
Crawford County	4	Livingston County	28	St. Clair County	9
Delta County	5	Luce County	0	St. Joseph County	21
Dickinson County	0	Mackinac County	2	Sanilac County	7
Eaton County	11	Macomb County	12	Schoolcraft County	0
Emmet County	7	Manistee County	2	Shiawassee County	8
Genesee County	17	Marquette County	1	Tuscola County	0
Gladwin County	1	Mason County	0	Van Buren County	4
Gogebic County	0	Mecosta County	2	Washtenaw County	28
		Menominee County	7	Wayne County	2
				Wexford County	8

Irrigation and Stock Water Use

The two major uses of water in agriculture are for stock watering and the irrigation of crops. Irrigation is increasing at a significant rate.

Stock Water Use

Large amounts of water of relatively good quality are required to maintain high performance levels of livestock. Water used for livestock purposes in 1979 ranged from 15 to 31.25 mgd. This value was calculated by multiplying the livestock population for 1979 by the basic water requirements for livestock (Hillman et al., 1975). In 1975, 25 mgd were used for livestock purposes in Michigan (Murray and Reeves, 1977). Of this amount, 19 mgd was obtained from ground-water sources and 5.7 mgd from surface-water sources. It is estimated that currently 80 to 90 percent of the water used for livestock in Michigan comes from domestic wells (Mr. Gale Arent, Cooperative Extension Service of Kalamazoo, personal communication).

Irrigative Water Use

The total estimated annual water withdrawal from all sources in Michigan in 1977 was 15,147 mgd (Bedell and Van Til, 1979). Of this total, 1.4 percent (212 mgd) was used for irrigation. Over half (55.9 percent) of the water used for irrigation in 1977 was obtained from surface sources, 42.2 percent was from wells, and 1.7 percent was from municipal sources.

Agricultural, recreational, and commercial irrigation were practiced either separately or in combination in every county in Michigan in 1977. The amounts of irrigation water applied, irrigated acreage, and the number of irrigators varies considerably among regions and counties, however, approximately half of Michigan's irrigation was concentrated in the southwestern portion of the Southern Peninsula (Bedell and Van Til, 1979).

In 1977, 2812 irrigators applied water to 324,934 acres throughout the state (table 3.91). Of the six counties in the state having 90 or more irrigators, five were located in southwestern Michigan. Six counties had 10,000 or more irrigated acres; all were located in southwestern Michigan (Bedell and Van Til, 1979).

Of the 324,934 irrigated acres in the state in 1977, 85.5 percent (277,937 acres) were in agricultural use, 9.2 percent (29,683 acres) were in recreational and cemetery use, 4.4 percent (14,399 acres) were in commercial use, and 0.9 percent (2915 acres) were classified as miscellaneous use. The five major uses in the agricultural category were field crops (62.2 percent), truck crops (12.7 percent), potatoes (11.6 percent), tree fruits (4.4 percent), and hay and pasture (4.1 percent). Golf course and park irrigation represent 96 percent of the irrigated acreage used in the recreation category. The commercial irrigation category included irrigated acreage in sod (64.4 percent) and flowers and nurseries (35.4 percent).

A total of 2,852,483 acre-inches of water was applied on irrigated land in Michigan in 1977 (fig. 3.11). Figure 1 displays the amount of water used for irrigation by county in the state in 1977. Application rates for all land-use categories per county ranged from 1.9 to 50.7 inches. The average application rate for the state was 8.8 inches, the highest rates for golf courses.

Between 1970 and 1977, the number of irrigators, irrigated acres, and amounts of water used increased in most Michigan counties. Qualitative assessments of irrigation trends by county extension offices reflected an expected increase in irrigated acreage in 70 percent of the counties in Michigan (fig. 3.12).

The increasingly common practice of irrigating with nitrate fertilizers is suspected of contributing to nitrate and nitrite levels in the ground water. The impact of irrigation on water quality should be studied systematically in the future.

TABLE 3.91 - SUMMARY OF IRRIGATION DATA BY COUNTY IN MICHIGAN, 1977.
(Source: D.J. Bedell and R.L. Van Til, 1977, Michigan Department of Natural Resources Water Management Division)

	Number of irrigators	Acres irrigated	Amount water used		Sources			Trend 2/	Avg. water use/year
					Well	Surface	Public		
			Ac-In	MG	% 1/	% 1/	% 1/		Inch 3/
Alcona	3	76	912	24.8	67	33	0	R.S.	12.0
Alger	4	30	63	1.71	25	75	0	Incr.	2.1
Allegan	75	9,240	61,591	1,672	30	70	0	Incr.	6.7
Alpena	21	350	4,189	114	25	75	0	Incr.	13.1
Antrim	19	1,442	6,213	169	59	41	0	Incr.	4.3
Arenac	12	1,068	5,782	157	22	67	11	Incr.	5.4
Baraga	2	16	58	1.57	0	100	0	R.S.	3.6
Barry	22	3,500	22,545	612	10	90	0	R.S.	6.4
[illegible]	43	4,800	15,909	432	0	100	0	Incr.	3.3
Benzie	19	540	12,343	335	67	33	0	Incr.	22.9
Berrien	157	8,604	77,631	2,108	28	72	0	Incr.	9.1
Branch	150	29,700	235,159	6,386	20	80	0	Incr.	7.9
Calhoun	67	18,600	158,916	4,315	80	20	0	R.S.	8.5
Cass	56	12,000	97,665	2,652	60	40	0	Incr.	8.1
Charlevoix	12	800	10,724	291	14	72	14	Incr.	13.4
Cheboygan	3	117	1,404	38.1	100	0	0	R.S.	12.0
Chippewa	3	80	321	8.72	0	100	0	R.S.	4.0
Clare	6	230	2,300	62.5	33	67	0	Incr.	10.0
Clinton	21	2,556	10,919	296	29	71	0	Incr.	4.3
Crawford	1	25	300	8.15	0	100	0	R.S.	12.0
Delta	15	605	2,072	56.3	13	87	0	Incr.	3.4
Dickinson	20	1,500	8,728	237	33	67	0	R.S.	5.8
[illegible]	15	1,045	6,270	170	50	50	0	Incr.	6.0
Emmet	15	455	2,212	60.1	63	12	25	Incr.	4.9
Genesee	24	1,495	4,845	132	23	69	8	Incr.	3.2
Gladwin	3	250	2,108	57.2	100	0	0	Incr.	8.4
Gogebic	2	53	630	17.1	0	75	25	Incr.	11.9
Grand Traverse	63	2,077	4,891	133	89	11	0	Incr.	2.4
Gratiot	12	1,000	5,929	161	36	64	0	Incr.	5.9
Hillsdale	38	5,366	33,664	914	19	81	0	Incr.	6.3
Houghton	18	565	1,413	38.4	0	100	0	R.S.	2.5
Huron	12	1,244	7,464	203	46	54	0	Incr.	6.0
Ingham	41	3,150	26,333	715	25	75	0	Incr.	8.4
Ionia	30	2,000	7,955	216	56	44	0	Incr.	4.0
Iosco	7	325	3,075	83.5	33	67	0	R.S.	9.5
Iron	6	482	1,282	34.8	12	76	12	Incr.	2.7
Isabella	18	3,230	9,690	263	67	33	0	Incr.	3.0

	Number of irrigators	Acres irrigated	Amount water used		Sources			Trend 2/	Avg. water use/year
					Well	Surface	Public		
			Ac-In	MG	% 1/	% 1/	% 1/		Inch 3/
Jackson	34	6,800	62,856	1,707	60	40	0	Incr.	9.2
Kalamazoo	49	7,213	43,298	1,176	37	63	0	Incr.	6.0
Kalkaska	8	1,245	6,694	181	25	75	0	Incr.	5.4
Kent	108	6,885	60,717	1,649	37	60	3	Incr.	8.8
Keweenaw	1	50	600	16.3	0	100	0	R.S.	12.0
Lake	2	80	900	24.4	100	0	0	R.S.	11.3
Lapeer	35	3,460	33,913	921	29	71	0	Incr.	9.8
[illegible]elanau	57	1,422	10,055	273	67	33	0	Incr.	7.1
Lenawee	12	2,076	10,588	287	37	63	0	Incr.	5.1
Livingston	35	2,210	29,393	798	60	40	0	Incr.	13.3
Luce	4	385	5,390	146	37	63	0	Incr.	14.0
Mackinac	4	4	96	2.61	75	0	25	R.S.	24.0
Macomb	100	5,500	46,750	1,269	11	85	4	Incr.	8.5
Manistee	72	3,500	33,384	907	20	79	1	Incr.	9.5
Marquette	8	964	5,484	149	18	55	27	Incr.	5.7
Mason	39	2,582	11,506	312	54	46	0	Incr.	4.5
Mecosta	28	7,655	76,680	2,082	38	56	6	Incr.	10.0
Menominee	6	347	2,850	77.4	15	85	0	Incr.	8.2
Midland	5	275	5,064	138	0	100	0	Incr.	18.4
Missaukee	23	2,834	23,065	626	55	45	0	Incr.	8.1
Monroe	27	2,195	14,268	387	44	56	0	Incr.	6.5
Montcalm	99	30,000	245,100	6,655	75	25	0	Incr.	8.2
[illegible]ntmorency	1	80	960	26.1	0	100	0	R.S.	12.0
[illegible]uskegon	46	8,285	419,843	11,400	46	51	3	Incr.	50.7
Newaygo	50	4,900	68,933	1,872	34	63	3	Incr.	14.1
Oakland	75	5,010	84,871	2,305	34	63	3	R.S.	16.9
Oceana	60	5,152	18,214	495	60	40	0	Incr.	3.5
Ogemaw	5	125	911	24.7	20	80	0	R.S.	7.3
Ontonagon	2	2	24	0.65	0	83	17	R.S.	12.0
Osceola	11	1,518	11,069	301	17	83	0	R.S.	7.3
Oscoda	2	125	1,841	50.0	0	100	0	R.S.	14.7
Otsego	3	320	1,768	48.0	100	0	0	Incr.	5.5
Ottawa	57	7,866	37,079	1,007	53	47	0	Incr.	4.7
Presque Isle	25	1,025	1,925	52.3	25	75	0	R.S.	1.9
Roscommon	5	199	2,330	63.3	50	50	0	R.S.	11.7
Saginaw	21	1,500	12,000	326	50	50	0	Incr.	8.0

	Number of irrigators	Acres irrigated	Amount water used		Sources			Trend 2/	Avg. water use/year
					Well	Surface	Public		
			Ac-In	MG	% 1/	% 1/	% 1/		Inch 3/
St. Clair	21	750	6,104	166	10	90	0	Incr.	8.1
St. Joseph	228	45,144	340,816	9,255	29	70	1	Incr.	7.5
Sanilac	23	2,565	21,537	585	43	57	0	Incr.	8.4
Schoolcraft	2	22	207	5.62	0	100	0	R.S.	9.4
Shiawassee	17	1,168	9,420	256	17	83	0	Incr.	8.1
Tuscola	19	3,097	15,485	420	25	75	0	Incr.	5.0
Van Buren	245	24,275	164,018	4,454	50	50	0	Incr.	6.8
Washtenaw	30	2,686	21,663	588	30	70	0	R.S.	8.1
Wayne	61	2,265	27,401	744	11	33	56	R.S.	12.1
Wexford	12	557	1,908	51.8	50	50	0	Incr.	3.4
	2,812	324,934	2,852,483	77,456					8.8

1/ Represents % of total number of sources in county, not related to amount of water used.

2/ R.S. - Acreage expected to remain the same in near future
Incr. - Acreage expected to increase in near future

3/ Acre Inches/Acre = Inches

COMMUNITY PUBLIC WATER SUPPLIES

WATER SUPPLY SERIAL NUMBER (WSSN)*	WATER SUPPLY AND OTHER AREAS WITH WATER SERVICE	POPULATION SERVED	OWNERSHIP**	AVERAGE DAILY PRODUCTION VALUE FOR YEARS OF RECORD (mgd)***	YEARS OF RECORD	HIGHEST AVERAGE DAILY PRODUCTION VALUE FOR YEARS OF RECORD* (mgd)	WATER SOURCE(S)	COMMENTS
	WASHTENAW COUNTY CONT'D							
7240	City of Ypsilanti Water Department 7200 Huron River Drive Ypsilanti, Michigan 48197	29,538	M	5.061	9	6.300 (74)	Drift wells	
	WAYNE COUNTY							
0130	City of Allen Park Water Department 16850 Southfield Road Allen Park, Michigan 48101	41,500	M	--	-	--	--	Water supply from Detroit (Great Lakes)
0580	City of Belleville Water Department 6 Main Street Belleville, Michigan 48111	2,600	M	--	-	--	--	Water supply from Detroit (Great Lakes)
0940	Brownstown Township Water Department 21313 Telegraph Road Trenton, Michigan 48183	7,300	T	--	-	--	--	Water supply from Detroit (Great Lakes)
1100	Charter Township of Canton Water Department 1150 South Canton Center Road Canton, Michigan 48188	8,800	T	--	-	--	--	Water supply from Detroit (Great Lakes)
1730	City of Dearborn Water Department 4500 Maple Dearborn, Michigan 48126	104,000	M	--	-	--	--	Water supply from Detroit (Great Lakes)
1740	City of Dearborn Heights Water Department 6045 Fenton Avenue Dearborn Heights, Michigan 48127	81,300	M	--	-	--	--	Water supply from Detroit (Great Lakes)
1800	Detroit Metro Water and Sewerage 735 Randolph Street Detroit, Michigan 48226	1,330,000	M	682.269	7	704.870 (73)	Great Lakes	
2050	City of Ecorse Water Department 4373 High Street Ecorse, Michigan 48229	17,500	M	--	-	--	--	Water supply from Detroit (Great Lakes)
2300	City of Flat Rock Water Department 25500 Gibraltar Road Flat Rock, Michigan 48134	4,910	M	0.915	2	0.939 (77)	Huron River	
2550	City of Garden City Water Department 6000 North Middlebelt Road Garden City, Michigan 48135	42,500	M	--	-	--	--	Water supply from Detroit (Great Lakes)
2680	City of Gibraltar Water Department 29411 Munro Avenue Gibraltar, Michigan 48173	3,900	M	--	-	--	--	Water supply from Detroit (Great Lakes)

COMMUNITY PUBLIC WATER SUPPLIES

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	WAYNE COUNTY CONT'D							
2870	Grosse Ile Township Water Department Township Hall 8841 Macomb Grosse Ile, Michigan 48138	7,900	T	--	-	--	--	Water supply from Detroit (Great Lakes)
2880	City of Grosse Pointe Water Department 17147 Maumee Avenue Grosse Pointe, Michigan 48230	6,800	M	--	-	--	--	Water supply from Detroit (Great Lakes)
2890	City of Grosse Pointe Farms Water Department 29 Moross Road Grosse Pointe Far . Michigan 48236	11,700	M	3.173	1		Great Lakes	
2900	City of Grosse Poin.. ... Water Department 15115 East Jefferson Avenue Grosse Pointe Par.. Michigan 48230	15,400	M	--	-	--	--	Water supply from Detroit (Great Lakes)
2910	Village of Grosse Pointe Shores Water Department 795 Lake Shore Road Grosse Pointe Shores, Michigan 48236	3,000	V	--	-	--	--	Water supply from Detroit (Great Lakes)
2920	City of Grosse Poi.. ...oods Water Department 20025 Mack Avenue Grosse Pointe Woods, Michigan 48236	22,100	M	--	-	--	--	Water supply from Detroit (Great Lakes)
2970	City of Hamtramck Water Department 9600 Buffalo Hamtramck, Michigan 48212	26,300	M	--	-	--	--	Water supply from Detroit (Great Lakes)
3020	City of Harper Woods Water Department 19617 Harper Avenue Harper Woods, Michigan 48236	20,400	M	--	-	--	--	Water supply from Detroit (Great Lakes)
3140	City of Highland Park Water Department 30 Gerald Avenue Highland Park, Michigan 48203	29,000	M	7.748	1	7.748	Lake St. Clair	
3320	Huron Township Water Department 37290 Huron River Drive New Boston, Michigan 48164	8,700	T	--	-	--	--	Water supply from Detroit (Great Lakes)
3360	City of Inkster Water Department 2121 Inkster Road Inkster, Michigan 48141	39,800	M	--	-	--	--	Water supply from Detroit (Great Lakes)
3870	City of Lincoln Park Water Department 500 Southfield Lincoln Park, Michigan 48146	50,500	M	--	-	--	--	Water supply from Detroit (Great Lakes)
3930	City of Livonia Water Department 13325 Farmington Road Livonia, Michigan 48150	119,000	M	--	-	--	--	Water supply from Detroit (Great Lakes)

COMMUNITY PUBLIC WATER SUPPLIES

WATER SUPPLY SERIAL NUMBER (WSSN)*	WATER SUPPLY AND OTHER AREAS WITH WATER SERVICE	POPULATION SERVED	OWNERSHIP**	AVERAGE DAILY PRODUCTION VALUE FOR YEARS OF RECORD (mgd)***	YEARS OF RECORD	HIGHEST AVERAGE DAILY PRODUCTION VALUE FOR YEARS OF RECORD + (mgd)	WATER SOURCE(S)	COMMENTS
	WAYNE COUNTY CONT'D							
4220	City of Melvindale Water Department 3100 Oakwood Bouelvard Melvindale, Michigan 48122	13,500	M	--	-	--	--	Water supply from Detroit (Great Lakes)
4830	City of Northville Water Department 215 West Main Street Northville, Michigan 48167	5,900	M	--	-	--	--	Water supply from Detroit (Great Lakes)
4845	Northville Township Water Department 16300 Sheldon Road Northville, Michigan 48167	3,500	T	--	-	--	--	Water supply from Detroit (Great Lakes)
5400	City of Plymouth Water Department 201 South Main Street Plymouth, Michigan 48170	12,500	M	--	-	--	--	Water supply from Detroit (Great Lakes)
5420	Plymouth Township Water Department 42348 Ann Arbor Road Plymouth, Michigan 48170	13,100	T	--	-	--	--	Water supply from Detroit (Great Lakes)
5640	Redford Township Water Department Township Hall 15145 Beech-Daly Road Detroit, Michigan 48239	72,400	T	--	-	--	--	Water supply from Detroit (Great Lakes)
5690	City of River Rouge Water Department 1381 Coolidge Highway River Rouge, Michigan 48218	15,500	M	--	-	--	--	Water supply from Detroit (Great Lakes)
5710	City of Riverview Water Department 17700 Fort Street Riverview, Michigan 48194	12,400	M	--	-	--	--	Water supply from Detroit (Great Lakes)
5750	City of Rockwood Water Department 32409 Fort Street Rockwood, Michigan 48173	3,050	M	--	-	--	--	Water supply from Flat Rock (Great Lakes-Huron River)
5785	City of Romulus Water and Sanitation Department 34100 Goddard Romulus, Michigan 48174	23,300	M	--	-	--	--	Water supply from Detroit (Great Lakes)
6170	City of Southgate Water Department 13763 Northline Southgate, Michigan 48195	36,000	M	--	-	--	--	Water supply from Detroit (Great Lakes)
6460	Sumpter Township Water Department 23483 Sumpter Road Belleville, Michigan 48111	2,600	T	--	-	--	--	Water supply from Detroit (Great Lakes)
6545	City of Taylor Water Department 23555 Goddard Road Taylor, Michigan 48180	80,300	M	--	-	--	--	Water supply from Detroit (Great Lakes)

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	WAYNE COUNTY CONT'D							
6650	City of Trenton Water Department 2800 Third Street Trenton, Michigan 48183	25,100	M	--	-	--	--	Water supply from Detroit (Great Lakes)
6770	Van Buren Township Water Department Township Hall 46425 Tyler Road Belleville, Michigan 48111	9,400	T	--	-	--	--	Water supply from Detroit (Great Lakes)
6950	City of Wayne Water Department 34808 Sims Wayne, Michigan 48184	21,700	M	--	-	--	--	Water supply from Detroit (Great Lakes)
7040	City of Westland Water Department 37137 Marquette Wayne, Michigan 48185	94,950	M	--	-	--	--	Water supply from Detroit (Great Lakes)
7180	City of Woodhaven Water Department 21869 West Road Woodhaven, Michigan 48183	7,400	M	--	-	--	--	Water supply from Detroit (Great Lakes)
7210	City of Wyandotte Department of Municipal Services 140 Elm Street Wyandotte, Michigan 48192	43,500	M	--	-	--	Great Lakes	
	WEXFORD COUNTY							
0970	Village of Buckley Water Department Buckley, Michigan 49620	244	M	--	-	--	Drift wells	
1030	City of Cadillac Cadillac Municipal Complex 200 Lake Street Cadillac, Michigan 49601	10,000	V	2.055	4	2.390 (70)	Drift wells	
4050	City of Manton Water Department 402 Michigan Avenue Manton, Michigan 49663	1,107	V	--	-	--	Drift wells	
4310	Village of Mesick Water Department North Eugene Street Mesick, Michigan 49668	376	V	--	-	--	Drift wells	